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ABSTRACT

Designed for business educators desiring to understand their role and responsibility in training students on the subject of metrics, this guide is a compilation of information supplemented by resource lists and discussion of the implications for specific business education courses. An introduction discusses the U.S. government and the metric system, the meter as a standard of measurement, metrics in education, and metric terms. Sections follow on commonly listed advantages of the metric system, the need for instruction, the instructional program, teaching materials, and metric topics for instruction. A short think-metric questionnaire is included along with a list of objectives and test questions for a short metric workshop or course. A section is devoted then to discussion of how metrication will affect business and industry, how it will affect business mathematics and mathematics-oriented business subjects, how it will affect consumer education, and how it will affect typewriting and related subjects. Appendixes contain various metric charts and other teaching aids and bibliographies of teaching materials and other resources for further information and for use in curriculum development. (HD)

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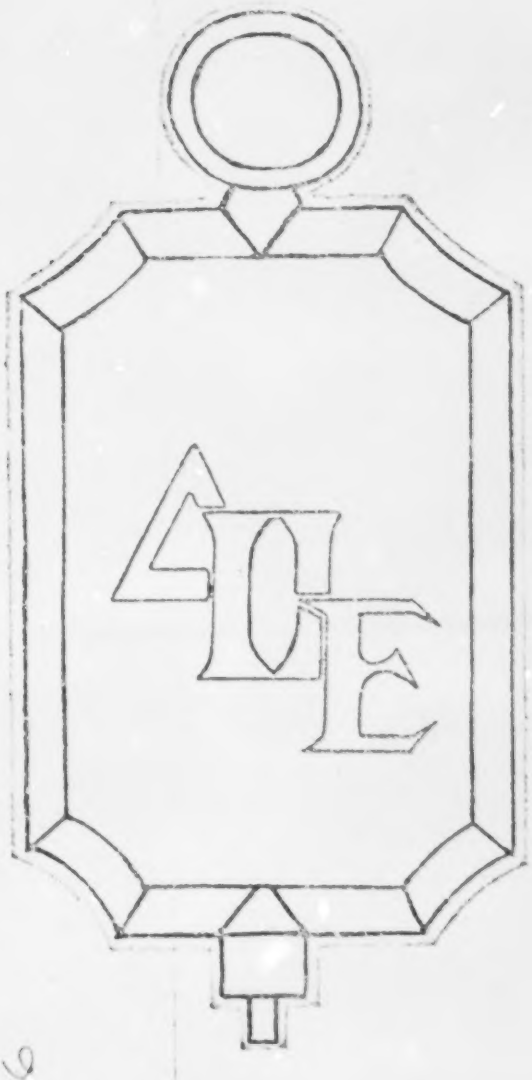
THE METRIC SYSTEM AND ITS IMPACT ON BUSINESS EDUCATION



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Delta Pi Epsilon fraternity, founded in 1936, is an honorary graduate organization for men and women devoted to the advancement and professionalization of business education. Through its ideals of service, leadership and cooperation, the fraternity strives to make significant and unique contributions to professional growth and scholarly achievement in business education. In the words of its founder, Dr. Paul Lomax, can be seen the scope of the fraternity, "The professional interests of *Delta Pi Epsilon* encompass the whole of business education in relation to the entire fields of American business and American education. Its membership. . . must always think in terms of the common good and advancement of all our business teachers and of all students who pursue courses in business education."

Beta Mu Chapter was founded in 1971. The chapter is located at Central Connecticut State College in New Britain, Connecticut.

THE METRIC SYSTEM AND ITS IMPACT ON BUSINESS EDUCATION

A Service Project

Presented To

Members Of
Beta Mu Chapter
Delta Pi Epsilon
Central Connecticut State College
New Britain, Connecticut

November 1976

Research Coordinators

Dr. H. J. Cameron, Chairman
Richard Grant
William Hanlon
Elizabeth A. Trudelle

Preface

Beta Mu Chapter of Delta Pi Epsilon at Central Connecticut State College in New Britain, Connecticut, chose "metrics" as the topic for their research project for 1976. The topic was chosen because of the major concern voiced by many business educators.

The research committee, Richard Grant, William Hanlon, and Elizabeth Trudelle, wish to thank those members who helped to prepare the report. A special "thank you" to Dr. Harrison Cameron, Coordinator, for his help and guidance; to Richard Dyer, Advisor, for his guidance and interest in our project; to Tom Yacavone, President, for his encouragement; to the staff at Elihu Burritt Library at Central Connecticut State College, and to the staff at Wilbur Cross Library on the University of Connecticut campus for their help in locating materials; to the United States Government Printing Office and South-Western Publishing Company for materials; to National Executive Secretary Dr. Ellis J. Jones for his help in referring us to sources where we could seek help.

It is the hope of the Beta Mu Research Committee that those who read the report are able to better understand what a responsibility they will have, or the role they will have to play, in the training of students on the subject of "metrics." The report is only a start for those who are interested in continuing to investigate "metrics" and its place in business education.

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THE METRIC SYSTEM AND ITS IMPACT ON BUSINESS EDUCATION

INTRODUCTION

Measurement affects our daily lives in many ways. We refer to measurement units when we buy shoes or lumber, when we travel from one place to another, weigh ourselves, make an appointment for a certain time of day, or listen to weather forecasts. Soon Americans will be thinking in terms of gram, liter, or meter. For example, a kilogram of ground beef will make eight to ten hamburg patties, and a liter of wine will serve a small dinner party.

The metric system, a decimal system, often referred to as S. I. (International System of Units) will soon become common. Most other countries already are using the metric system. The United States will be one of the last major nations to take official steps toward conversion to the metric system. Ninety percent of the world's population inhabits countries in which the metric system is firmly established or in which the process of conversion is underway. Legislation which has been pending in Congress for more than a decade puts the conversion to the metric system on a voluntary basis; however, acceptance has to be apparent. Terms such as pounds, quarts, inches, and such will be abandoned.

United States Government and the Metric System

The United States Government has now taken an official position toward converting to the metric system of measurement. President Ford signed P.L. 94-168, the Metric Conversion Act of 1975, on December 23, 1975. The Metric Conversion Act creates a United States Metric Board composed of 17 members. Industry, education, the scientific and engineering communities, consumers, other groups who have a major interest in the conversion to the metric system, and the public at large are represented on the Board. The act calls for voluntary conversion, with each segment of the economy adopting the metric system as conversion best serves its interest. The Board will help coordinate "voluntary plans" for conversion. Provisions are not made in the Act for subsidies for the research and development of programs; however, P.L. 94-168 does authorize over $2 million to be appropriated for the first year of operation to cover salaries and expenses of the Metric Board. It is expected that, once the Board perfects plans calling for the major education of various segments of the population, amendments to the Act will be passed to provide authorization for such programs. The cost involved in the changeover, however, will be borne by individual companies at a time when they decide it is advantageous for them to convert. A target date for completion of the conversion has not been determined. The Act does not stipulate a specific time within which conversion must be accomplished, but it does provide official government support of the conversion.

Before the Metric Conversion Act of 1975 was passed, the United States Office of Education under P.L. 93-380 (a special-projects act under Title IV, Part C, Section 403) initiated a program of metric education. The funding of FY 1976 was approximately $2 million. The cutoff date for research and development project proposals under the provision was December, 1975. Projects are well on their way to being contracted. During the past two years, the National Institute of Education and the United States Office of Education, Division of Research and Development have spent some funds (a limited amount) on projects which were directed toward metric education.

The Meter, A Standard of Measurement

With more than half of our canned goods labeled in both metric and standared (English) measure, the meter is becoming a standard measurement. The American Automobile Association claims 13 states have new highway signs showing distances in both kilometers and miles. However, in Connecticut it has been reported that the Chief of Traffic Engineering for the State Department of Transportation is not receptive to such signs. James Rice says that he has no plans to convert to the metric system. There is a sign, however, on I-91 near the Middletown, Connecticut, area which gives the distance to Hartford in miles and the equivalent in kilometers. Rice claims this was only an effort to measure public reaction--most reactions were unfavorable because of the cost to taxpayers. The chemical, food, pharmaceutical, and scientific companies have been using the metric system extensively for many years (in 1894 the metric system was adopted by the United States War Department for medical words and in 1902 the metric system was adopted by the United States Health Department). Examples include: 35 and 16mm film, physicians write their prescriptions by indicating weight in grams, metric tools for repair work, and international sporting events.

Metrics in Education

There have been recommendations that priorities should be given to educating school-age children and the general public to "Think Metric." The National Education Association's goal is to train people to use the metric system as a primary system by 1980. Some states plan to convert all textbooks to the metric system by 1980, and others have set 1984 as a goal.

The conversion to the metric system will be for teachers of all levels and subject areas. The teachers will be the hardest people to train because they have used nothing but inches and feet since early days in school. It will be necessary for teachers to force themselves to stop thinking in terms of "converting" inches into centimeters and so forth. Business teachers must think only in terms of centimeter and meter. Students must be able to communicate in metric terms as citizens. The orientation of most teachers will not approach the education required for mathematics and science teachers, who will have to teach, not just use the system. Because the teachers will have to assume the responsibility of preparing themselves, their pupils, and subsequently the public to live in a metric America, metric education will be required for all

teachers. As long as educators stress the importance of thinking metric, metrication will be an efficient, effective, and enjoyable process. The business teacher will have his share of responsibilities during the changeover to the metric system. Business education textbooks will have frequent measurement references. The use of metric paper as well as the vocabulary of the international metric system of measurement, its structure, abbreviations, and symbols will be a factor. Many educators and young people say the metric method is actually easier than the "English" system because the metric system uses the decimal relationship between units--fractions are seldom used.

The metrication suggestions for business and office education classroom teachers as proposed by Dr. Lila L. Prigge at the National Business Education Convention in San Francisco include: business and office education instructors should become familiar with the metric system, they should encourage their administrators to provide in-service programs, they should order materials and information from organizations and publishers which will help familiarize them with the system and use the materials in their classroom, they should write to publishers of business education textbooks and urge the publishers to change textbooks so that they can teach metrics--include metric units, they should urge administrators to designate one person to gather materials and information on the metric system and make the information available to teachers, and they should attend workshops and/or classes which are devoted in some way to the metric system.

The changeover to the metric system will not be as difficult as most Americans believe it will be. Naturally, there will be confusion because a new system is being learned. Most people will learn the use of the system. Continued exposure to the metric system and its application to everyday experience will make the students as well as the teacher more comfortable with the system and its uses. Some activities which may be used in the classroom could be: plan a bulletin-board display with the theme, "Think Metric;" cut out ads in which the metric system is used and discuss the material; or give a recipe in metrics for the students or their family members to follow.

Metric Terms

In learning a language, one must learn hundreds of words; however, in learning the metric system a person must learn terms such as meter, liter, and gram, and a minimum of six prefixes. (See Appendix A for comparison chart of metric and "English" terms.) The meter is the measurement of length, the liter is the measurement for dry and liquid volume, and the gram is the measure of weight. Milli is a prefix meaning one-thousandth; centi, a prefix meaning one-hundredth; deci, a prefix meaning one-tenth; deka, a prefix meaning ten times; hecto, a prefix meaning one hundred times; and kilo, a prefix meaning one thousand times. The base or starting point is with the meter, liter, or gram; and the other measurements are in either descending or ascending order. The system is based on multiple of tens and the decimal point is moved to change from one unit to another. For example, 1,235 millimeters would be 123.5 centimeters, 12.35 decimeters or 1.235 meters.

Temperature is expressed as Celsius (C), formerly referred to as Centigrade, instead of Fahrenheit (F). Water freezes at $0^{o}C$ and boils at $100^{o}C$. Body temperature is $37^{o}C$, and a comfortable temperature is 20^{o} to $25^{o}C$ which is equivalent to 68^{o} to $77^{o}F$.

Individuals will not have to learn every facet. However, one will need to remember that a meter is a little longer than a yard (39.37 inches), a liter is a little over a liquid quart (1.06) and a gram is about the same weight as a paper clip (0.35 ounces).

COMMONLY LISTED ADVANTAGES OF THE METRIC SYSTEM

The metric system has many advantages over the "English" system. A list appeared in *The Arithmetic Teacher*, April, 1973. The advantages include:

1. The metric system is a simple, logically planned system. It's decimal basis conforms to our numeration system.

2. The meter, which establishes the basis for the entire system, is always reproducible from natural phenomena and, therefore, is immune to destruction; it is international in character and well-suited for precision work. The coordination of measures of length, area, volume and mass, combined with decimalization, facilitates computations.

3. Once the system of prefixes has been learned, the uniformity in names for all types of measures makes for greater simplicity and ease in changing to more convenient-sized units for specific purposes.

4. Although many of the claims of the amount of time that can be saved in learning fractions are probably exaggerated, less competence in manipulation of common fractions would be required of many students, and some restructuring of time spent on such computation might be profitably accomplished. Ultimately, when only the metric system would be taught, time could be saved in learning of conversion units (1 ft. = 12 in., 1 rd = 16½ ft., 1 mi. = 5280 ft., and so on) and in the learning of a second new system for use in science classes.

5. For ordinary work, familiarity with the meter, gram and liter would be sufficient. However, for the engineer and the scientist, the new International System of Units (SI), based on the metric units, eliminates conversion problems in calculations with derived units. That is, although power is universally defined as work per unit time, it is variously expressed in Btu/sec., therms/day, ft-lb/hr., horsepower, calories/sec., watts, and so on. The use of two different terms, kilogram and newton, for units of mass and force, respectively, eliminates much of the confusion students have concerning these concepts.

6. Greater participation of the United States in the setting of international engineering standards would be possible since the metric system is the universal language of measure. Exports, foreign trade, and competition with other nations will depend more and more on production under metric standards.

7. A common measurement language that is used by scientists, engineers, and industrial workers would improve communication and reduce barriers between different sectors of society.

8. The necessity of conversion to the metric system offers fringe benefits. During the adjustment to the new measurements, there would be opportunities to eliminate superfluous varieties in sizes of products, parts, and containers, and to make additional worthwhile changes in engineering standards, construction codes, and products design.

NEED FOR INSTRUCTION

All schools need to introduce metric measurements into their instructional programs. Schools must provide for the replacement of measuring tools, the changing of equipment, and the use of metric supplies. In addition, in order for the metric system changeover to be successful we must set goals, set a planning stage, and determine who actually will do the planning. If the shift to metric is left to chance, schools may end up with sporadic efforts scattered in many different directions, each costing time and money. Communication of the suggested policy should include a statement as to what type of instruction should be used and at what level the instruction should be used. The action should include the appointment of a metric manager to organize public information.

Metric education timetable. The metric education timetable should include--a time during which the public becomes aware of the metric system through announcements, conferences, and publicity; and, a time when the public should be encouraged to "think metric" by common usage of terms such as meter, millimeter, centimeter, kilometer, liter, gram, kilogram, and Celsius. Metric workshops such as in-service courses should be conducted. Between 1976 and 1980, the implementation phase should be used. During this time people would see the activation of metric as the primary unit of instruction. Substitution of metric units for customary (English) units would be made in references, measurements, labeling, publications, communications, signs, and charts. Emphasis should be placed on using whole metric units. By 1980, the year it is proposed that preliminary education should be completed, the full use of metric terminology, practice, and standards in all measurements, specifications, publications, texts, and references should be used. It will be difficult to use only one spelling of the metric terms. Mathematics teachers' associations and American National Metric Council have come out for the "er" spelling of meter and liter and the American Metric Association, metric journals and magazines have opted to the use of the "re" form--metre and litre.

INSTRUCTIONAL PROGRAM

In planning a metric instructional program, three strategies should be regarded as a basis according to information in a United States Bureau of Standards publication and the April, 1975 issue of *National Business Women* magazine.

1. Need to Know. Everyone needs to know the basics of metrics, but not everyone will need to know everything about metrics. Many people will only need to know those terms and practices necessary to substitute metric terms for the "English" measurement instructions. Teaching everything about metrics before the information is needed would be a waste of time and effort. It is not necessary to memorize all of the metric symbols, prefixes, base units, and derived units since only a few will be needed in every-day practice.

2. Compare, don't Convert. It is necessary only to make comparisons of the "English" system with the metric system. The process of converting arithmetically from "English" to metric will not be possible. Substituting metrics for the customary "English" is possible.

3. Metric First. When writing measurements, it would be beneficial to first write the metric terms followed by the "English" measurement in parentheses. Using the metric unit first will promote rounding off in metric as we now do in the "English" system. It will take about two hours minimum for acquiring concepts, letting the knowledge "soak in" and using the new knowledge to perform varying tasks.

TEACHING MATERIALS

Items which can be used to teach metrics include: a 100 cm wall chart hung one meter from the floor; 30 cm (12 in.) rulers; labels from can goods; measuring tapes; wall chart with thermometer with an even numbered Celsius scale on the left and a Fahrenheit scale on the right; a wall chart showing a container with liter on the left and gallon on the right; and other wall charts showing both the metric and the "English" system.

A program of affixing bumper stickers to cars will make the general public more aware of the "Think Metric" program.

METRIC TOPICS FOR INSTRUCTION

The following is a listing of topics or information which could be used to instruct students about the metric system: Jefferson's attempt to improve measurements in the United States; Congressional recognition of metrics as valid for contracts during 1866; comparison of basis for the "English" system; use of metric system by 90% of the world by 1950; adoption of metric system in 1965 by England followed by Canada and Australia; United States switch to metric as recommended by a 1971 Commerce Department report; recent moves by large international corporations to use the metric system; public use of metrics for road signs; weather reports giving Celsius temperature; articles, pictures, and cartoons in newspapers and magazines.

The tentative metric timetable should be used as a guide. The awareness phase will last until 1976. It is planned that the changeover phase will continue until 1980. Hopefully the full metric commitment will come after 1980.

A THINK METRIC QUESTIONNAIRE

The following is a group of questions which were suggested in the March-April, 1974 issue of *Shop Instructor* magazine to be used in a class where metrics has been explained:

1. What is your personal height in centimeters (cm)?
2. What is your personal mass (weight) in kilograms (kg)?
3. Find the width and length in millimeters (mm) of a sheet of letterhead paper.
4. Give the thickness and width in millimeters (mm) of a small book.
5. What is the mass in grams (g) of the contents of a container from the grocery shelf?
6. Give a room door width and height in centimeters (cm).
7. What is normal room temperature in Celsius (C)?
8. A car tankful (20 gal.) of gas is how many liters (l)?
9. The national legal speed limit is how many kilometers per hour (km/hr)?
10. Give the distance from your present location to a nearby city in kilometers (km).

A WORKSHOP OR COURSE

Objectives. The objectives of a workshop or course in metrics to train people in the field of metrics are: (1) upon completion of two hours students should be able to name the most used metric units; (2) be able to measure and describe common objects in metric units; (3) "Think Metric" in terms of travel, distances, and everyday life.

Testing knowledge gained. In order to test the understanding of those who complete a workshop or course, the following questions which were adopted from a group of questions suggested in an article from the *Metric Association* may be used:

1. What is the basic unit of mass? (a) gram, (b) kilogram, (c) jouile, (d) meter
2. What is the basic unit of distance: (a) gram, (b) liter, (c) meter, (d) kilometer
3. What is a small unit of capacity? (a) gram, (b) cubic centimeter, (c) millimeter, (d) meter

4. What is the shortest unit of distance in common measurement? (a) kilometer, (b) decimeter, (c) centimeter, (d) millimeter

5. The 30 centimeter ruler will replace present rulers with a length of (a) 12 in., (b) 18 in., (c) 24 in., (d) 36 in.

6. A personal height of 5 ft. 6 in. would be (a) 110 centimeters, (b) 140 centimeters, (c) 170 centimeters, (d) 200 centimeters

7. A tall basketball player's height (6 ft. 6 in.) is (a) 160 centimeters, (b) 180 centimeters, (c) 200 centimeters, (d) 220 centimeters

8. A personal mass (weight) of 180 pounds is (a) 80 kilograms, (b) 100 kilograms, (c) 140 kilograms, (d) 180 kilograms

9. One-half kilogram of hamburger would have a mass (weight) of (a) about one pound, (b) a little less than two pounds, (c) a little more than two pounds, (d) about four pounds

10. A kilogram is about equal to (a) one pound of butter including the package, (b) a two pound can of coffee including the can, (c) a three pound canned ham including the can, (d) a five pound bag of dog food including the bag

11. A liter of milk would have volume a little larger than a (a) pint, (b) quart, (c) half gallon, (d) gallon

12. A 20 liter can of fuel is comparable to a (a) one gallon can, (b) two gallon can, (c) three gallon can, (d) five gallon can

13. Normal body temperature on the Celsius scale (a) $37^{o}C$, (b) $42^{o}C$, (c) $47^{o}C$, (d) $52^{o}C$

14. The distance in kilometers from Albany to New York City (150 miles) is (a) 120 kilometers, (b) 150 kilometers, (c) 190 kilometers, (d) 240 kilometers

HOW WILL THE METRIC SYSTEM AFFECT BUSINESS AND INDUSTRY

Non-manufacturing businesses. For non-manufacturing businesses, metric conversion would in general require considerably fewer changes in machinery tools, and other physical things, although they might translate customary (English) dimensions into metric dimensions. They would also incur costs in retraining employees, maintaining dual inventories, and modifying or replacing scales, gasoline pumps and other weighing and measuring devices.

Labor. Labor unions are concerned about possible costs to their members for new tools and also for retraining. Some labor leaders are deeply concerned about a more subtle cost, which can be termed "loss of experience." Take the automobile mechanic who, after years on the job, instinctively reaches for the right wrench to loosen a bolt. When working for the first time, or even the tenth time, on a metric engine, he cannot rely on his instinct. The mechanic

unfamiliar with metric tools works slightly more slowly, less surely, and is therefore not quite so productive for a while. If he is a senior craftsman, he may even be at some disadvantage with respect to a metrically trained newcomer.

Education. Changing textbooks and equipment would cost millions of dollars spread over a period of three to five years. If they were changed for no other reason than going metric, the cost could be attributed to a metric changeover. In fact, however, most textbooks are replaced anyway after a few years of use and, thus, most of the millions of dollars could be completely absorbed and would not appear as an extra item in school budgets.

Training teachers who are still not familiar with the metric system would represent another expense. But since most teachers pursue programs of continuing education, the cost would probably be small and could be absorbed.

The American Association for the Advancement of Science mentioned an additional intangible benefit. It has been found that slower children learn metric more readily than they do the customary (English) system--a factor that could not possibly be expressed in monetary terms.

Much more important, though, is the time that could be saved if students did not have to be drilled in fractions necessary to cope with the customary (English) system. Estimates varied, but mathematics teachers said that in elementary school they spend from 15 to 25 percent of their class time driving home the details of adding, subtracting, multiplying, and dividing common fractions. They believe much of this is unnecessary. If the metric system, with its simpler decimal relationship, were taught, they could rapidly give their pupils the basic principles of fractions and then move on to other useful aspects of mathematics.

Manufacturing. The construction industry is one of the most complicated industries to change. Its activities are closely interlocked with those of a host of manufacturing industries--e.g., steel, glass, plastics, and timber. It employs a wide variety of skilled and professional people, including architects, civil engineers, electricians, steamfitters, and experts in heating and ventilation, and building maintenance. The conversion to metric materials and components will cost billions of dollars.

Transportation and communication industries, which affect the lives of almost everyone, are less common in private ownership than they are in the government. Whether publicly or privately controlled most of these industries will have to work out a timetable for conversion.

Tariffs for delivering goods, people, and messages are generally based on combinations of weight, bulk, and distance. Thus, old tables can be converted to new ones that are almost exactly equivalent.

So far as the traveler is concerned, metrication of the railroads will mean little, except that timetables including distances will be revised at some time for reprinting. But the people who run the railroads will have to become accustomed to new operating manuals with speeds, distances, weights, pressures, and other dimensions expressed in metric terms when the change is made.

Metrication of shipping and navigation is primarily a matter of rewriting in new units various acts, rules, and regulations.

The airlines have long dealt with a mixture of metric and customary (English) units and will continue to do so until there is an international agreement to change. Since they already weigh freight and baggage in kilograms, conversion of customs and other regulation to metric will be an added convenience.

There is unlikely to be any early change in air navigation practices, particularly in units used for air-to-ground communications in traffic control or for the calibration of flight instruments. International civil aviation uses two different sets of standards; both include the knot and nautical mile, but one set measures speed and vertical distances in kilometers per hour and meters, the other in miles per hour and feet.

In engineering there is no other group of industries which will be changed so profoundly. Precise measurement is a basic activity of engineering firms, and the use of new units of measurement affects every aspect of the firm's business. Although most inch-based machine tools can be used without modification to produce metricated components, some users will be faced with the need to convert their machines to a dual role or to metric working, and in some instance to replace them. Most machines can be readily converted, and conversion kits are now generally available.

BUSINESS MATHEMATICS AND MATHEMATICS ORIENTED BUSINESS SUBJECTS

Business Mathematics

More than any other course in the business education department, business mathematics should include instructions in the use of the metric system. As a result, business mathematics teachers will be required to alter their materials used in instructing students.

Students will have to be informed as soon as possible, through a unit on the International System of Units, about the advantages of the tens or the decimal numeration system--introduce the metric system or measurement to the students. The student should understand the conversion from our "English" system to the "new" international units.

One way of teaching "metrics" to business mathematics students is to gradually reduce the use of the "English" system and gradually introduce the metric system. Fractions may be a starting point since fractions are not used in the metric system. As result, emphasis will be placed on decimals which apply to the metric system. No matter how metrics is taught in business mathematics, memorization except for basic terms--meter, liter, and grams--and the common prefixes should not be required. The changeover should be regarded as a challenge and not a problem by both the teacher and the students.

If we were to compare the metric system to the "English" system, we could use the following problems for a comparison: (taken from an example given in *Ninth District Exponent, Vol. II, No. 11, The United States and the Metric System* by Susan Fraker Holt)

Customary (English) system. You have just bought a new water bed 6 feet wide, 7 feet long, and 9 inches thick. How many gallons of water will it hold? How many pounds will it weigh full of water?

$\frac{6}{1} \times \frac{7}{1} \times \frac{9}{12} = \frac{63}{2} = 31.5$ cubic inches

One cubic foot of water weighs 62.5 pounds.

```
  31.5 cubic feet
 x62.5 pounds
  1575
   630
 1890
1968.75 pounds (weight of bed)
```

There are 1,728 cubic inches in a cubic foot, and 231 cubic inches in a gallon.

```
   1728 cubic inches
 x31.5 cubic feet
  8640
 1728
5184
54432.0 cubic inches


      235.6 gallons of water
231)54432.0
   462
    823
    693
    1302
    1155
     1470
     1386
```

Metric system. You have just bought a new water bed 183 centimeters wide, 213 centimeters long, and 23 centimeters thick. How many liters of water will it hold? How many kilograms will it weigh full of water?

183 centimeters
x23 centimeters
549
366
4209 square centimeters
x213
12627
4209
8418
896517 cubic centimeters

There are 1,000 cubic centimeters in a liter. Therefore, your bed holds 896.517 liters. One liter of water weighs one kilogram. Your bed weighs 896.517 kilograms.

Instruction on the metric system should be taught with the idea in mind that mathematics books and workbooks are presently including more information on instructional materials on the metric system. In the February, 1975, issue of *The Journal of Business Education*, William Selden explains that there are five types of problems that can be used in offering instruction in the metric system. They include:

1. Problems converting an "English" measurement to a metric measurement. For example: Change 20 gallons to liters.

20 x 3.8 = 76 liters, or 20 ÷ .26 = 76 liters

2. Problems converting a metric measurement to an "English" measurement. For example: Change 50 centimeters to inches.

50 ÷ 2.5 = 20 inches, or 50 x .4 = 20 inches

3. Problems devoted entirely to the metric system. For example: Find the area of a room 20 meters by 20 meters.

20 x 20 = 400 meters^2

4. Problems when pupils are asked to measure some type of object. For example: In centimeters, how long is the pencil you are using. (Answer may be 15 centimeters.)

5. Problems which call for estimated answers. For example: In terms of meters, how long is the classroom? (Answer may be 12 meters.)

(Other problems may be found in Appendix H.)

Laboratory approach. The laboratory approach has been proven as an excellent way to interest business mathematics students in metrics. If the approach is used, students will be required to measure items, determine volume, etc. As a result, the business mathematics classroom will have to be equipped with measuring tapes, metric sticks, equipment for determining weight and mass, etc.

Because the entire metric system is based on 10, the problems involving multiplication or division are simple. Students should be taught that in order to work from a base unit to smaller units, move the decimal point to the right; or, that to work from the base unit to larger units, move the decimal point to the left. Also, when working with area (some measure squared) or with capacity (some measure cubed), move the decimal point 2 places for square measures and 3 places for cubic measure for every one move in straight measure.

The following example shows the meter as the base:

km ← hm ← dam ← meter → dm → cm → mm

0.0196 km ← 0.196 hm ← 1.96 dam ← 19.6 m

19.6 m → 196 dm → 1960 cm → 19 600 mm

An activity which is helpful to making students understand how to perform calculations is that of comparing quantities. For example: What is heavier your pen or your shoe? Which student is tallest? Does a soda can hold as much liquid as a carton of milk? Or students may be told to measure areas such as a desk top, a textbook, or height.

Mathematics-Oriented Business Subjects

Bookkeeping, accounting, recordkeeping, and cost accounting are mathematics-oriented business subjects. The subjects will deal with some problems which include linear and volume measurements.

Since the fields of bookkeeping, recordkeeping, and accounting deal primarily with financial measures which are already in the decimal system, only a few significant changes will be required. Cost accounting frequently deals with the calculation of the cost of units for production. When the units of production are linear or volume measures, then a change to the international system will have to be made.

CONSUMER EDUCATION

How Metrication Will Affect the Individual Consumer

The teacher of Consumer Education must introduce metric units of measurement more extensively to allow the student to gain a practical awareness of the effects of the new measuring system in day-to-day living.

There is a great deal of apprehension about metrication; most consumers seem to be under the impression that on some specific date the use of the inch, the quart, and the pound, etc., will suddenly cease; and from that day on they will have to wrestle with the unfamiliar units of the meter, the liter, and the kilogram.

The change will not take place so abruptly. However, we are not going to change slowly into metrication, either. The Federal metrication program as planned contemplates a massive and immediate change to the metric system through an intensive education program designed to make the general public familiar with the system, as well as to get people to accept it. The changeover will not be sudden, but it is hoped that once the conversion from our present system to the metric system is started it will move along at a fairly rapid clip. Also, it has been accepted as a matter of course that in a few areas there will never be conversion.

The rule of reason will apply in deciding if a specific change to metric is justified. These areas may be divided into two categories: (1) traditional matters in which the customary system of measurement is such an integral part of our life that there would be almost complete resistance to change, and (2) areas where it would be economic idiocy to attempt a change to the metric system.

An example of the first category would be football. There is no doubt that the length of a football field will remain 100 yards instead of changing it to 91.44 meters, and it is very unlikely that you will hear a sports announcer say anything on the air such as, "third down, one and eight tenths meters to go." Baseball diamonds and basketball courts will probably continue to be laid out in customary units also, at least in the foreseeable future.

In track, field, and swimming, however, distances and other measurements that have yet to be metricized probably will be rather quickly because Olympic measurements in these sports are all in metric terms. The Olympic-size swimming pool is now common for all competition, and the 100-meter dash has in many places replaced the 100-yard dash. Broad jumps, high jumps, pole vaults, and distance throws are measured in metric terms in many schools in order to make it easier to prepare for Olympic competition. Therefore, there is little opposition to complete metrication in track-and-field competition.

In the second category a good example is this nation's railroad lines. It certainly would be economic idiocy to even suggest that all the railroad track in the country be torn up and replaced by the metric-gauge track used in Europe. Metrication will never take place here, even as track wears out and has to be replaced, because two different gauges of track in a railroad system would require two different sets of wheels and axles for every locomotive and car that passed over the track. Therefore, we will go on with a nonmetric railroad system because under the rule of reason that is the only direction that could be taken.

It is extremely unlikely that all property records will be rewritten in the metric system as least in the next century. Local governments will move very cautiously, if at all, in converting all their property records to metric standards. Those that do decide to convert will probably do so only when property changes hands. It might take as long as two hundred years before con-

version is completed as property is something that requires measurement--perhaps once in a lifetime or even only once in several lifetimes.

When technicians refer to the conversion to metrics, they use the terms "soft conversions" and "hardware conversions." Soft conversions are simply changes in terminology. Measuring units are simply converted from the customary to the metric system without changes in the lengths, volumes, or masses measured. As an example, when the news media now reports that the new Miss America has measurements of 91-63-89 that will be a soft conversion. When metrication is completed and the old tape measure (inch) is replaced with a metric tape to measure Miss America, this would constitute a hardware conversion. Similarly, when the local radio station converts the temperature registered on its Fahrenheit outdoor thermometer in order to report the weather to its listeners in metric terms, this will be a soft conversion. If the radio station purchases a Celsius thermometer so that the weather newscaster no longer has to use a conversion chart, this will be a hardware conversion.

The average consumer will first be encountered with soft conversions. The consumer will find himself buying 500 grams of hamburger instead of one pound. He will be paying slightly more than previously, too, because store managers will not be inclined to sell meat in units of 454 grams and will round out standard food quantities to even figures in grams and kilograms. Therefore, the consumer may be buying slightly over 1-1/2 ounces more of hamburger than he is used to buying.

This principle will also apply to other food items. When buying vegetables you will discover that the old ounce-pound scale has been replaced with a metric scale. The scale will register 1-1/2 kilograms when you place three pounds of onions on the scale. Actually, this will be 40 grams more than 3 pounds. When you weigh what looks to you like about 10 pounds of potatoes, the scale will register slightly over 4-1/2 kilograms (about 36 grams more than 10 pounds).

The selling and buying of bulk foods in metric units incorporates such simple soft conversion that it should cause little difficulty once America goes metric. Prepackaged foods such as sausage, hot dogs, bacon, and cheese will begin the change to the metric system by simply adding the printing of metric equivalents to the customary weights shown on the package. A package of sausage will read: 1 lb.: 454 g.

Once the consumer becomes accustomed to buying in metric units, the packagers will change the size of the packages to round out their contents to even numbers of grams or kilograms and the dual listing of weights will be eliminated. While this change will involve a hardware conversion for the food packager, it will still be only a soft conversion from the standpoint of the consumer.

In fact, all metric unit changes in consumer items, regardless of whatever hardware conversions were necessary in the factories, will be soft conversions as far as the consumer is concerned because to the consumer it simply means a change in terminology. Instead of asking for a shirt size 15-33 1/2, he will ask for one sized 38-85.

The simplest hardware conversion that will be taking place will be in the American home. This will occur when the old wooden yardstick is thrown away and replaced with a meter stick. When the bathroom scale wears out, a new one is purchased that registers weight in kilograms and hectograms. A new electric stove with a Celsius temperature scale on the oven will constitute a third hardware conversion.

Another day-to-day conversion adjustment that will have to be made is that of the average homemaker as regards to the cooking of the family meals. As recipes are published in newspapers, magazines and new cookbooks, they will require metric measurements of the different ingredients needed in the preparation of the recipe. As a result, the homemaker is going to have to go out and buy metric measuring devices while still retaining the customary ones for those old favorite dishes. (See Appendix I.)

One of the first soft conversions you will encounter outside of the home, other than the supermarket, will be road and highway signs. Speed limits will be adjusted to the nearest round figure. Twenty-five miles per hour will convert very closely to 40 kilometers per hour, but 30 miles per hour converts to about 48 kilometers per hour. The latter will probably be raised to 50 kilometers per hour. Fifty miles per hour converts very closely to 80 kilometers.

Distances, of course, will be converted exactly to the nearest tenth of a kilogram, just as they are presently given to the nearest tenth of a mile.

Until such time when all automobiles can be equipped with metric speedometers, distances and speed limits will have to be posted in both metric and customary (English) units in order to avoid confusion and the chance of accidents due to the mental preoccupation of a driver if he were required to make constant conversion in his head while driving.

Various school systems have already begun to teach the metric system instead of the customary (English) one, and it will not be long before all American school children will receive their basic instruction in metrics. If the rest of the Federally directed conversion program develops as it is hoped, the process of conversion will be relatively painless for the average American citizen.

TYPEWRITING AND RELATED SUBJECTS

Typewriters. Typewriters by design and construction are compatible with the metric system. Presently, the plan is to have two scales on the typewriter where the metric measurement will be used as an overlay to the "English" measurement system. The plan follows what is seen today in the grocery store where weight is expressed in "English" measurement and metric measurement. It "stands to reason" that our present practice of using six lines equal one inch or 10 or 12 characters per inch will be approximately the same.

Once typewriters are metricized, all typewriters in an office will have to be replaced; stationery will have to be changed in size--so new stationery will have to be developed; and publishers will have to revise textbooks accordingly. As a result, business teachers will be forced to teach students on the basis of centimeters--number of spaces or centimeters to the line; number of centimeters from the top of the page (for manuscript or letter set-up); number of typewritten spaces to the centimeter; number of lines to a centimeter vertically; and number of centimeters as well as inches in referring to measurement when setting up any document, manuscript, tabulation, and so forth.

Paper. Size of paper is another interesting topic. A business teacher can continue to use the present size with the dimensions rounded to even centimeters; continue the present size with a gradual change to millimeters (215.6 x 279.4 mm = 8.5 x 11 inches); continue the present size with dimensions rounded to even millimeters (215 x 288 mm = 8.46 x 11.02 inches); adopt the International Organization for Standardization A-4 size (210 x 297 mm = 8.27 x 11.69 inches); adopt the compromise G-4 size (210 x 280 mm = 8.27 x 11.02 inches); or adopt a new size. (See Appendix F.)

Conversion. A few writers in business education express a belief that teachers should not attempt to have students convert from standard or "English" measurement to metric measurement since presently the metric system is not widely used. They feel there is no need for typewriting students to convert inches into centimeters or millimeters, but that typewriting students should be taught to think in terms of number of keystroke spaces--which may be easier for the students to understand.

Much of the argument from the few writers is based upon the fact that metric-size paper may not be widespread for some years. However, in checking the New London County area of Connecticut, it is a known fact that some Government offices and private business firms are already using metric-size paper. Therefore, students should not be denied the opportunity to learn how to use metric-size paper, nor should they be denied the opportunity to learn how to apply the metric system to their typewriting. A point to remember is that the students of today will live a major part of their lives living and working with the metric system.

ISO Typewriter

There is a proposal of a ISO typewriter. At the National Business Education Association Convention on April 15, 1976, Dr. Lila Prigge gave a listing of the five major changes of the proposed ISO typewriter keyboard. The changes will include: (1) exchange the hyphen and underline key with the diagonal and question mark key; (2) add the superscript ^{2} for use with units of area; (3) add the superscript ^{3} for use with units of volume; (4) add the degree symbol to be used with degrees Celsius; and (5) add the Greek letter mu to be used as the symbol for the prefix micro. (See Appendix G.)

Teaching the Metric System in Typewriting

A teacher of typewriting can give the students the opportunity to use metric size paper by having 8-1/2 x 14 standard size paper cut to size. Or, if funds permit, the so called A-4 size paper can be purchased. Also, the students can construct a metric ruler from paper or purchase a ruler for a very small amount of money.

Beginning typewriting. Presently, in beginning typewriting classes, business teachers are teaching students that there are 10 pica spaces to an inch and that there are 12 elite spaces to an inch. Soon these same business teachers, using only metric scales, will be saying that 10 pica spaces construct 2.5 cm; 12 elite spaces make up 2.5 cm; and six vertical lines equal 2.5 cm. Since students tend to become confused, a business teacher should not tell students that 10 pica spaces equal one inch; therefore, there are also 10 pica spaces to 2.5 cm, since one inch equals 2.5 cm. An important point to remember in changing from the "English" system to the metric system is that we forget the concept of inches. By using the metric terms and by making no reference to the "English" terms students tend to think in terms of the metric system only.

Margins. When business teachers begin to teach margins to students when only the metric scales are used, it is important that only the metric system be stressed. Students must be told to set margins of 2.5 cm, or 3.75 cm, or 5 cm. Terms such as two-and-a-half or three-and-three quarters should not be used; however, the decimals should be used as two-point-five and three-point seven-five cm. When teaching margins using the metric system, business teachers will no longer be able to use a 4", 5", or 6" margin, but they must explain for a short letter 5 cm margins are used; for a medium letter 3.75 cm margins are used; and for a long letter 2.5 cm margins are used. Also, no longer will it be correct to teach leave a 1", 1½", or 2" margin, but a business teacher will teach for an unbound manuscript to use 2.5 cm margins on the left, right, and bottom with a 3.75 cm or 5 cm margin at the top on the first page, and a 2.5 cm margin on all other pages. For a left-bound manuscript, a 3.75 cm left margin, 2.5 cm margin on the right and bottom, and 3.75 cm or 5 cm top margin on the first page, and a 2.5 cm top margin on all other pages is used. For a top-bound manuscript, 2.5 cm margins on the left, right, and bottom, with a 6.25 cm top margin on the first page, and a 3.75 cm top margin on all other pages are used.

Although it may be some time before metric-size paper comes into widespread use, the use of the paper should not be different for teachers and their students. The use of metric-size paper will not necessitate change of any of the existing scales on the typewriter. The metric-size paper known as A-4 is 210 mm wide and 297 mm long--meaning that metric size paper is slightly narrower and slightly longer than the standard typewriting paper which measures 21.5 cm x 28 cm.

Some helpful information for business teachers when metric-size paper is used and when no change is made on the existing scales on the typewriter include:

Horizontal centering. The paper guide must be in the proper position. To do so, a student should follow the following directions: fold a sheet of paper in half; place the right edge of the folded paper at the mid-point on the carriage-position scale; adjust the paper guide so that it touches the left edge of the paper; and mark the position of the paper guide on the machine with a felt marking pen. Once the mark is made, it will not be necessary to fold a piece of paper in half each time the typewriter is used. Because the paper guide is in the proper position, margins can be set to the right and left of the mid-point on the carriage-position scale according to the predetermined length of the typewriting line.

Vertical centering. The rules which are used for vertical centering on metric-size paper are basically the same as are used for standard paper. One point which must be stressed is that there are 70 typewriting lines on a piece of metric paper.

Notes and manuscripts. A 60 pica keystroke space line or 70 elite keystroke space line should be used for notes and manuscripts. If the manuscript is to be bound on the left, the left margin stop can be moved five additional spaces to the right.

Letters and envelopes. Most students in typewriting today are told when "setting-up" a letter try to have the same number of spaces between the date and the inside address as you have between the signature and the bottom of the page. However, when the metric paper is used, an additional two spaces should be left between the date and the inside address. Another rule to follow would be to type the date on the fifteenth typing line and not the thirteenth as is used on standard paper.

When teaching the typewriting of envelopes, using standard paper, the business teacher usually instructs the students to type the address one space below the vertical center of the envelope and five spaces to the left of horizontal center. The same instruction applies when using metric paper.

Numbers. When metric numbers are typed, a space is omitted after three numbers to the right and to the left of the decimal point. If there is no number before the decimal point, a "0" is used. For example, 45 867; 7 483.786; 0.817 425.

Metric spelling and symbols. Students should become familiar with metric spellings and symbols and how to type the symbols. For instance, "cm" is a symbol and not an abbreviation. Symbols are written in lower case letters, and there is a space before and after the symbol. The symbol is not followed by a period unless it is typed at the end of a sentence. There is no typewriter symbol for liter because the letter "l" is used for the number "1." However, the script "l" can be used as the symbol. When using the metric symbol, the plural is the same as the singular.

Punctuation. At the National Business Education Association Convention in San Francisco, Dr. Lila Prigge of the Area Vocational Technical Institute in East Grand Forks, Minnesota, explained a list of rules of punctuation in the ISO Metric System. The rules include: (1) Use the comma as the decimal marker. (2) A zero must always be written to the left of the decimal sign when there are no integers. (3) Use a space to separate groups of three in numerical values such as thousands. (4) The abbreviations for metric terms are in fact not abbreviations but symbols and thus are never followed by a period. (5) Most of the common symbols are written in lower case except capital C for Celsius. Some of the less common symbols used in scientific areas are written with capital letters. (6) The plural "s" is never used with metric symbols. (7) Units of area and volume must be written with a small exponent. (8) An ordinary lower-case "l" could, in some contexts, be mistaken for the figure "one"; therefore, the script or the word "liter" written out should be used. (9) Whenever practical, decimal notation should be used instead of fractions.

Terms. The following is a table of terms which are used with use of the metric system.

Linear Measure		Mass Measure		Capacity Measure	
millimeter	mm	gram	g	milliliter	ml
centimeter	cm	kilogram	kg	liter	"l"
meter	m	ton	t		
kilometer	km				

Typewriter Related Courses

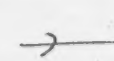
The metric system will affect subjects such as clerical training, secretarial procedures, and office practice. These subjects are primarily concerned with the desirable amount of border to use in order to frame correspondence. Once again, in place of one inch the teacher will now use the term 2.5 centimeters are required or 1½ inch must be expressed as 3.75 centimeters.

In typewriter-oriented courses, topics such as office equipment, furniture, and production measures are covered. Much of the information is expressed in linear form. When the metric system is adopted, there are a few changes that will have to be made. A chart will have to be developed to explain the conversion of the standard-size cards and correspondence into centimeters or millimeters. Alterations will have to be made in areas dealing with correspondence, filing, and office layout.

Effects of the metric system on the office worker is hoped to be minimal. Brief instructions will have to be given on the linear international system.

SHORTHAND

Shorthand will have to accommodate the new terms which the metric system will introduce. Some possible Gregg Shorthand brief forms for the metric terms may include:

	METER	LITER	GRAM
MILLI			
CENTI			
DECI			
DEKA			
HECTO			
KILO			

SUMMARY

If the metric system sounds awesome, it will probably remain that way until we learn our present system and think metrically.

With the passage of the Metric Conversion Act of 1975, the need to be informed about and to progress toward conversion was heightened. It seems probable that future workers may lose vital job opportunities if they are not equipped to cope with and use metric measurement as part of their daily jobs.

With or without the benefit of Federal legislation, the metric system is well on its way to becoming established as the standard form of measurement in the United States. Americans will be thinking of meters instead of inches; liters in place of pints and quarts; and grams in place of ounces and pounds.

The metric system is actually easy to learn. One has only to learn 10 units and get used to a few new temperatures; of course, there are other units which most people will not need to learn. There are even some metric units with which we are already familiar. The units for time and electricity are the same as we now use.

The basic units are: meter--which is a little longer than a yard (kilometer--0.62 miles; centimeter--0.39 inches); liter--a little larger than a quart; gram--about the weight of a paper clip (kilogram--2 pounds plus).

Conversion to the metric system will better enable the American industries to compete with industries in other nations. As a result, there will be greater output and higher profits.

When America changes to the metric system, education will play an important role. The changeover will be gradual, not sudden, and will proceed in an orderly fashion. Instruction about the metric system will take place in the business education courses. The metric conversion does carry far-reaching implications for vocational and technical educational programs. Literature during the last two years has shown the foresight and intent of vocational and technical educators in the conversion to the metric system.

Teachers will have to remember that in teaching the metric system they must: avoid converting units from one system to another; demonstrate the decimal relationship between units; teach the metric system throughout the curriculum; and relate the metric system to the everyday experiences. They must not convert metric to "English" or "English" to metric--think only in metric terms; and, not simply add a unit on the metric system to the existing curriculum.

Recent articles published in Connecticut newspapers during June and July show that Connecticut has taken steps towards implementation of metric education. The Connecticut State Department of Education has received an $82,966 grant from the United States Department of Health, Education, and Welfare to assist with

implementation of metric education in a nine-state region. The Connecticut State Department of Education will coordinate the grant for a regional consortium of the six New England states, New York, New Jersey, and Pennsylvania, with approximately 10 million school children. The program includes several areas involved in introducing and teaching the metric system in all levels of education. In an effort to avoid duplication of studies and materials development, each state will take over development of various guidelines to be used in all states' metric education projects. Delegations of the areas to be studied by each state will be the decision of the Northeastern States Metric Education Consortium, which will meet in September.

Areas which the delegations will study include: a plan to implement the metric program in the multi-state area; proper curriculum for kindergarten through grade 12; tailoring of materials and approaches in metric education to special learning capacities, such as the gifted student and the student with learning disabilities; guidelines for introducing metric education into teacher preparation programs and the implications for teacher certification; existing and new materials for parent education through programs such as parent-teacher associations; development of materials for bilingual instruction in the metric system; materials and curriculum for adult education classes; development of a policy statement of cooperation from the business, industrial, and academic communities; and planning a series of workshops in metric education for teachers, parents, and school administrators.

APPENDIX A

	1000	100	10	1	1/10	1/100	1/1000
Decimal System	thousands	hundreds	tens	ones	tenths	hundredths	thousandths
Metric System	kilo	hecto	deka	unit	deci	centi	milli
Symbols	(k)	(h)	(da)		(d)	(c)	(m)

(Material was taken from a bulletin prepared by the Curriculum Services, Pennsylvania Department of Education.)

APPENDIX B

DECIMAL NUMERATION

THOUSANDS	HUNDREDS	TENS	ONES		TENTHS	HUNDREDTHS	THOUSANDTHS
				.			

KILO (BASE UNIT)	HECTO (BASE WORD)	DEKA (BASE WORD)	(BASE WORD)		DECI (BASE WORD)	CENTI (BASE WORD)	MILLI (BASE WORD)
				.			

METRIC SYSTEM

APPENDIX C

The following is a chart taken from *The Modernized Metric System*, a booklet published by J. J. Keller & Associates, Inc. of Neenah, Wisconsin.

USE OF METRIC SYMBOLS

QUANTITY	METRIC UNIT	SYMBOL
Length	millimeter	mm
	centimeter	cm
	meter	m
	kilometer	km
Area	square meter	m^2
	hectare (10 000 m^2)	ha
Volume	cubic centimeter	cm^3
	cubic meter	m^3
	liter (0.001 m^3)	"l"
	milliliter	ml
Mass (Weight)	gram	g
	kilogram	kg
	metric ton (1 000 kg)	t
Time	second	s
	minute, hour, day, etc.	min, h, d, etc
Speed	meter per second	m/s
	kilometer per hour	km/h
Power	watt	W
	kilowatt	kW
Electric Current	ampere	A
Temperature	degree (Celsius)	^oC

APPENDIX D

MANUSCRIPTS BY METRIC

(Adopted from the article written by Alan Storm in *The Balance Sheet*, April, 1974.)

UNBOUND MANUSCRIPT

Top Margin: 3.75 cm on first page
2.5 cm on all other pages

Side Margins:
Right Margin: 2.5 cm
Left Margin: 2.5 cm

Bottom Margin: 2.5 cm

LEFT-BOUND MANUSCRIPT

Top Margin: 3.75 cm on first page
2.5 cm on all other pages

Side Margin:
Right Margin: 2.5 cm
Left Margin: 3.75 cm

Bottom Margin: 2.5 cm

TOP-BOUND MANUSCRIPT

Top Margin: 6.25 cm on first page
3.75 cm on all other pages

Side Margins:
Right Margin: 2.5 cm
Left Margin: 2.5 cm

Bottom Margin: 2.5 cm

APPENDIX E

The following material was taken from a Style Manual for the International Systems of Units, which was prepared by Honeywell, Incorporated.

COMMON METRIC DO'S AND DON'TS

DO'S

Use the correct American spelling. Special problems are metre, litre, gram, and the tonne (metric ton) as past practice has carried on these words. Add "s" to indicate plural units unless otherwise indicated.

Use the correct capital and lowercase upright Gothic letters for symbols.

K for kelvin	k for kilo
M for mega	m for metre
N for newton	n for nano

NOTE: Symbols are identical in all languages.

Use a zero before a decimal quantity less than 1.

0.601 mm	not	.601 mm
0.2 g	not	.2 g

Leave a full or half space between the number and the symbol, if the first character of the symbol is a letter.

0.601 mm	not	0.601mm
0.2 g	not	0.2g
25°C	not	25 °C

Use a dot (.) between symbols when units are multiplied together.

newton metre and N·m

When dividing use the word per between words or an oblique stroke (/) between symbols.

kilogram per cubic metre = kg/m^3

metre per second squared = m/s^2

DON'TS

Do NOT pluralize symbols.

5 mm	not	5 mms
8 kg	not	8 kgs

Do NOT put a full stop (period) after a symbol except at the end of a sentence.

Do NOT use prefixes alone.

kilometre or kilogram NOT kilo

Do NOT mix customary (English) and metric units.

kilogram per cubic metre (kg/m^3), NOT kilogram per gallon (kg/gal)

Do NOT use double prefixes.

use gigawatt	not	kilomegawatt
use picafarad	not	micromicrofarad

Do NOT use prefixes in the denominator of compound units (exception, the kilogram is preferred to the gram in the denominator).

use kilogram per cubic metre -- kg/m^3
NOT kilogram per cubic centimetre -- kg/cm^3

NOT gram per cubic millimetre -- g/mm^3

BUT USE joule per kilogram NOT joule per gram

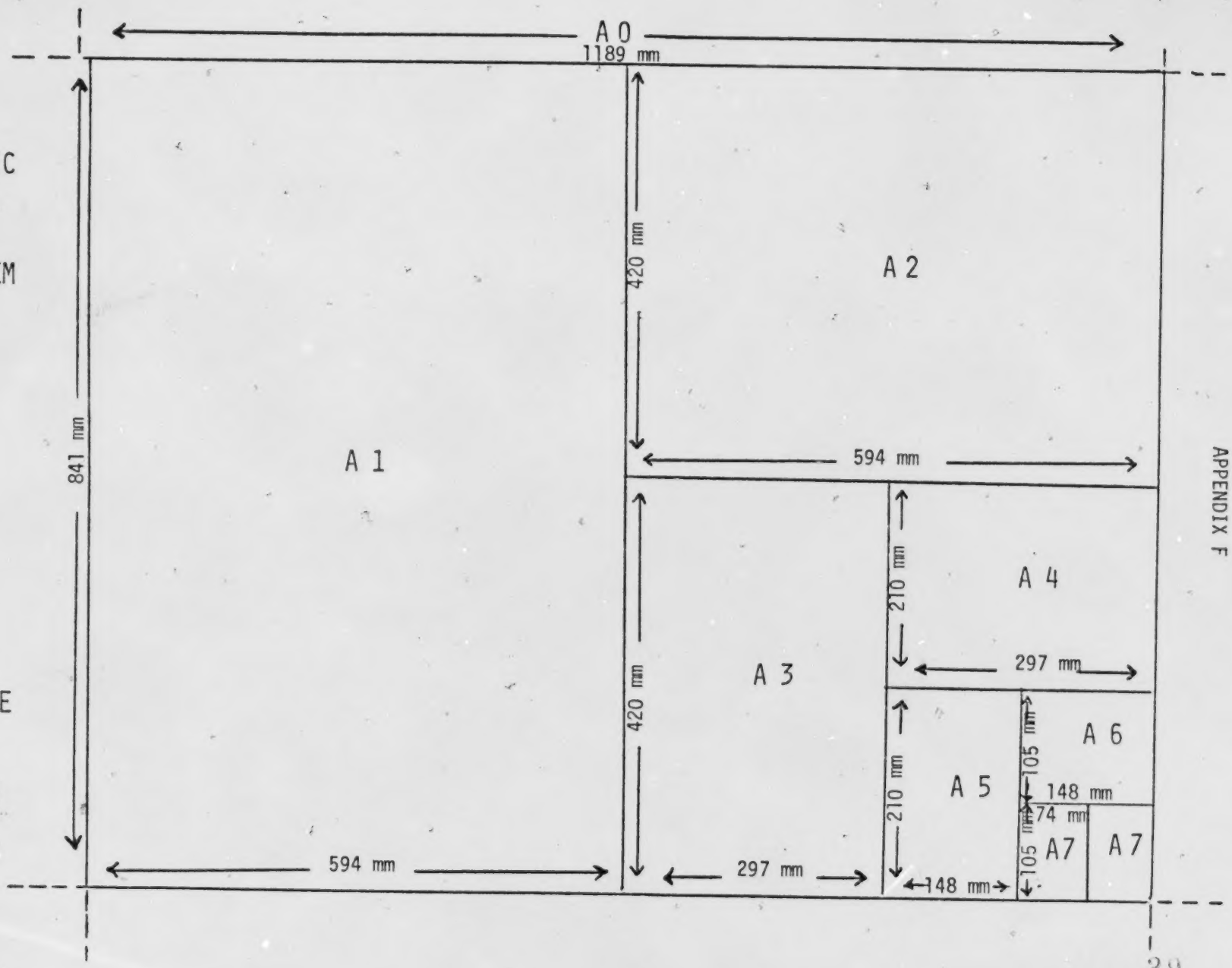
Do NOT use a comma as a thousands marker, use a space instead. Many countries using the metric system use a comma as a decimal marker.

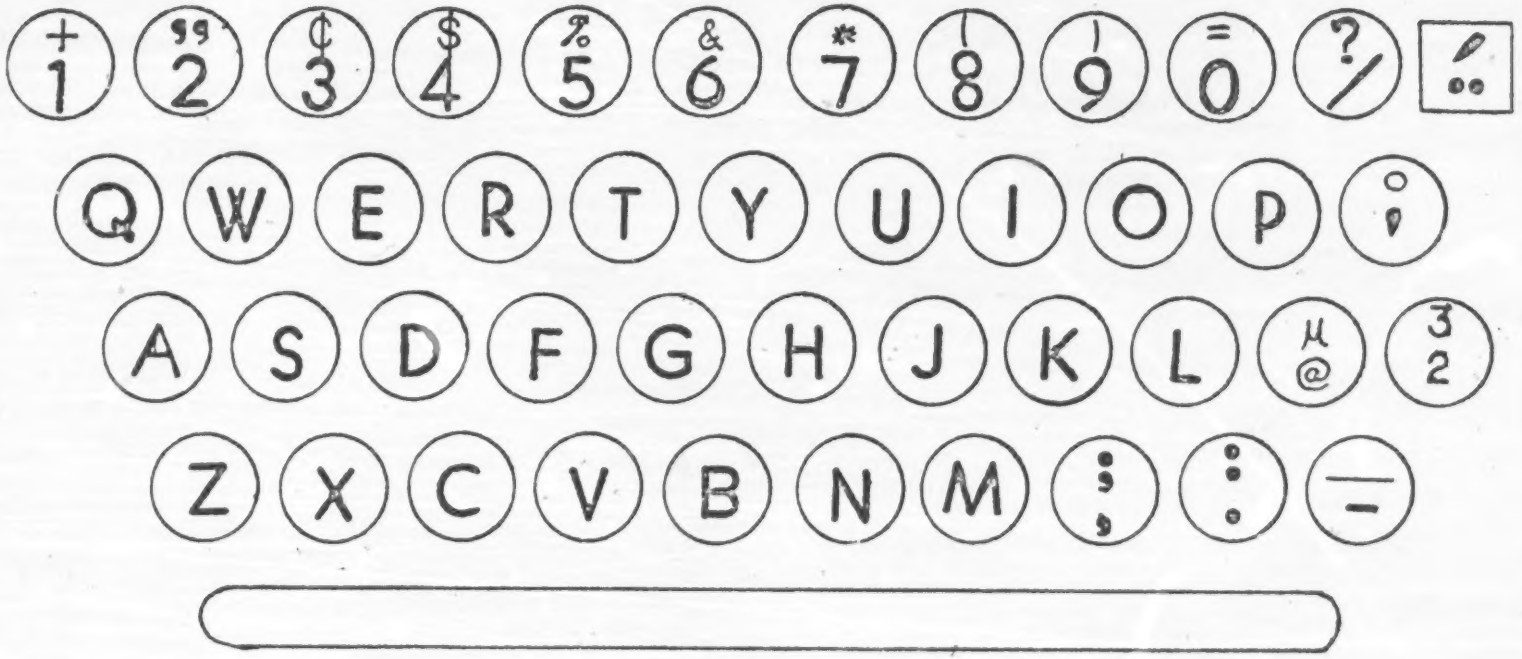
Use 459 321.3979 NOT 459,321.3979

NOTE: Spaces are not used on engineering drawings.

METRIC SYSTEM

A SIZE PAPER





AN INTERNATIONAL TYPEWRITER KEYBOARD

FOR THE UNITED STATES

(Proposed by Albert J. Mettler, Canadian Metric Association)

APPENDIX H

METRIC PROBLEMS

NBEA 1976 - San Francisco
Dr. Lila Prigge
Area Vocational Technical Institute
East Grand Forks, Minnesota

1000	100	10	1	•	0.1	0.01	0.001
kilo	hecto	deka	base unit		deci	centi	milli

Using the above chart as a guide, complete the following problems.

GROUP A

1. 1 meter = _____ decimeters
2. 1 liter = _____ centiliters
3. 1 gram = _____ milligrams
4. 10 meters = _____ dekameter
5. 100 liters = ____ hectoliter
6. 1000 grams = _____ kilogram
7. 1 decimeter = _____ centimeters
8. 10 millimeters = _____ centimeters
9. 10 dekameters = _____ hectometers
10. 26 centimeters = _____ millimeters

GROUP B

1. 600 cm + 40 dm = _____ m
2. 30 dal + 7 hl = _____ kl
3. 25 kg + 65 dag = _____ g

GROUP C

1. 800 dl + 9600 cl = _____ ℓ
2. 2 m + 3 dm + 4 cm = _____ mm
3. 2.7 ℓ + 4.7 cl = _____ ml
4. 2 g + 12.5 dg = _____ cg
5. 8 hm + 4 dam + 5 m = _____ km

APPENDIX I

RECIPES*

Many metric recipes are already available. This one, for instance, is for a Date and Nut Bread. Try it. If, for the moment, you would rather stick with the way you've always done things, we've also included a version of the recipe that calls for all the customary measurements.

METRIC METHOD

Date and Nut Bread

700 milliliters unsifted flour
15 milliliters baking powder
5 milliliters salt
1 package (283.5 grams) pitted dates, chopped
125 milliliters chopped nuts
175 milliliters sugar
50 milliliters corn oil
1 large egg
150 milliliters milk
150 milliliters orange juice

Grease and lightly flour 22.9x12.7x7.6 centimeter loaf pan. In bowl stir together flour, baking powder and salt. In small bowl stir dates and nuts with small amount of dry ingredients.

In large bowl beat together sugar, corn oil and egg until smooth. Stir in milk and orange juice. Stir in dry ingredients. Fold in date mixture. Turn into prepared pan.

Bake in 176 degrees C. oven 1 hour 15 minutes or until cake tester inserted in center comes out clean. Cool in pan 15 minutes. Remove from pan and cool completely on rack before slicing. Makes 1 loaf.

CUSTOMARY "ENGLISH" METHOD

To make Date and Nut Bread by the customary method: Use 2-3/4 cups unsifted flour, 1 tbls. baking powder, 1 tsp. salt, 1 package (10 oz.) pitted dates, chopped, 1/2 cup chopped nuts, 3/4 cup sugar, 1/4 cup corn oil, 1 egg, 2/3 cup milk, and 2/3 cup orange juice. Turn into 9x5x3-inch loaf pan. Bake in 350 degrees F. oven 1 hour and 15 minutes.

*Recipes appeared in Wednesday, April 21, 1976, issue of *The Day*, New London, Connecticut, pg. 19.

U. S. DISTANCES IN KILOMETRES

FROM	TO	DISTANCE
Seattle, WA	Chicago, IL	3 300km
Boise, ID	Trenton, NJ	4 100km
San Francisco, CA	New York, NY	4 900km
Los Angeles, CA	Denver, CO	1 800km
San Diego, CA	Portland, ME	5 200km
Denver, CO	Atlanta, GA	2 250km
San Antonio, TX	Duluth, MN	2 000km
Austin, TX	Akron, OH	2 100km
Chicago, IL	Atlanta, GA	1 120km
Miami, FL	Boston, MA	2 500km

KITCHEN CONVERSION CHART

1 drop = 1 drop
1 tablespoon = 15cm^3 also c.c. or ml
1 teaspoon = 5cm^3 also c.c. or ml

1/3 cup = 80ml
1/4 cup = 60ml
1/2 cup = 125ml
1 cup = 250ml
2 cups = 500ml
3 cups - 750ml
4 cups = 1 000ml (1 litre)

1 cup of granulated sugar weighs about 250 grams
1 cup confectioners sugar weighs about 150 grams
1 cup brown sugar weighs about 200 grams
1 cup of molasses, honey, or syrup weighs about 375 grams
1 teaspoon of cornstarch weighs about 30 grams
An ordinary egg (average) weighs about 60 grams
7 tablespoons of butter weigh about 100 grams
11 tablespoons of all purpose flour weigh about 100 grams
7 tablespoons of sugar weigh about 100 grams
About 8 average bananas weigh a kilogram
The coldest spot in your freezer is about minus thirty degrees Celsius (C).
The average temperature in the freezer is around minus twenty degrees C.
Water freezes at 0 degrees and boils at 100 degrees C.
A slow oven is 130 degrees C.
A moderate oven is 180 degrees C.
You do deep-fat fry at 190-200 degrees C.
A hot oven will be 240-260 degrees C.
You boil at 285-290 degrees C.

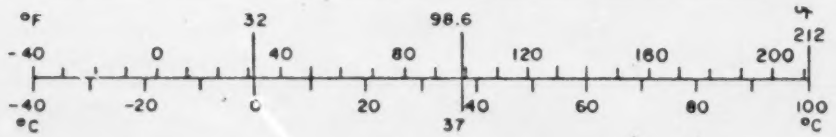
U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C. 20234

NBS Letter Circular 1051
July 1973

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



*1 in = 2.54 cm (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10: 286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

This Letter Circular (LC1051) provides conversion factors for going from the more common customary units to metric units and vice versa. It may be reproduced freely. LC1051 is based on NBS Special Publication 365 (Revised Nov. 1972), "Metric Conversion Card", available by purchase as a wallet-size plasticized card from the U.S. Government Printing Office, Superintendent of Documents, Washington, D.C. 20402. Price 20 cents domestic postpaid, or 10 cents GPO Bookstore. Stock Number 0303–0168. Catalog No. C13.10: 365/2. (25 percent discount on orders of 100 or more copies).

GPO 876-671

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AHEA Sales Office (American Home Economics Association), 2010 Massachusetts Ave., N.W., Washington, D. C. 20036

AIMS Instructional Media Services, Inc., Box 1010, Hollywood, CA 90028

Allyn & Bacon, Inc., 470 Atlantic Avenue, Boston, MA 02210

AMA/COM or AMACON, Division of American Management Association, 135 W. 50th Street, New York, NY 10020

American National Metric Council, 1625 Massachusetts Ave., N.W., Washington, D. C. 20036

American National Standards Institute, 1430 Broadway, New York, NY 10018

American Society For Testing and Materials, 1917 Race Street, Philadelphia, PA 19103

BFA Educational Educational Media, 2211 Michigan Avenue, Santa Monica, CA 90404

Bro-Dart, 1609 Memorial Avenue, Williamsport, PA 17701

Canadian Metric Association, Box 35, Fonthill LOS 1E0, Ontario, Canada

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Creative Visuals, Box 1911--S3--A, Big Spring, TX 79720

Denoyer-Geppert, 5235 Ravenswood Avenue, Chicago, IL 60640

Educational Filmstrips Press, Huntsville, TX

Educational Products, 5005 W. 110th Street, Oak Lawn, IL 60453

Educational Teaching Aids, 159 Kinzie Street, Chicago, IL 60610

Houghton-Mifflin Company, 110 Tremont Street, Boston, MA 02107

Ideal Pictures, 4431 W. North Avenue, Milwaukee, WI 53208

Instructional Fair, Inc., 1225 Bowers Street, Birmingham, Michigan 48012

Instructor Publications, Inc., 7 Bank Street, Dansville, NY 14437

International Business Machines Corporation, Old Orchard Road, Armonk, NY 10504

Janus Associates, Box 96, Wethersfield, CT 06109

Kent Educational Service, P. O. Box 903, Oviedo, FL 32765

The Math Group, Inc., 5625 Girard Avenue South, Minneapolis, MN 55419

Metric Commission, Box 4000, Ottawa, Ontario

Metric Studies Center, American Institutes for Research, Box 1113, Palo Alto, CA 94302

Metrix Corporation, P. O. Box 19101, Orlando, FL 32814

McGraw-Hill, Incorporated, 1221 Avenue of the Americas, New York, NY 10020

National Audiovisual Center (GSA), Washington, DC 20409

National Bureau of Standards, Washington, D. C. 20234

National Council of Teachers of Mathematics, 1906 Association Drive, Reston, VA 22091

National Education Association, American Education Week, P. O. Box 327, Hyattsville, MD 20781

National Microfilm Association, Suite 1101, 8728 Colesville Road, Silver Spring, MD 20910

National Textbook Company, 8259 Niles Center Road, Skokie, IL 60076

The Ohio State University, The Center For Vocational Education, 1960 Kenny Road, Columbus, OH 43210

Pathescope Educational Films, Inc., 71 Weyman Avenue, New Rochelle, NY 10802

Public Affairs Office, George C. Marshall Space Flight Center, Marshall Space Flight Center, Alabama 35812

Random House, The School Division, Westminster, MD 21157

Real-T-Facs, P. O. Drawer 449, Warwick, NY 10990

Society For Visual Education, Inc., 1345 Diversey Parkway, Chicago, IL 60614

Stanley Tools, P. O. Box 1800, New Britain, CT 06050

Sterling Educational Films, N. E. 34th Street, New York, NY 10016

Swani Publishing Company, Box 248, Roscoe, IL 61073

TAD Products, 639 Massachusetts Avenue, Cambridge, MA 02139

Union Carbide Corporation, Public Relations Department, 270 Park Avenue, New York, NY 10017

United States Metric Association, Sugarloaf Star Route, Boulder, Colorado 80302

Uniten Systems, 246 W. 34th Street, Indianapolis, Indiana 46208

University of Vermont, Mrs. Virginia Jodoin, Consumer Specialist, 211 Terrill Hall, Burlington, VT 05401

Visual Education Consultants, Box 52, 2066 Helena Street, Madison, Wisconsin 53701

Visual Instruction Productions, 295 W. 4th Street, New York, NY 10014

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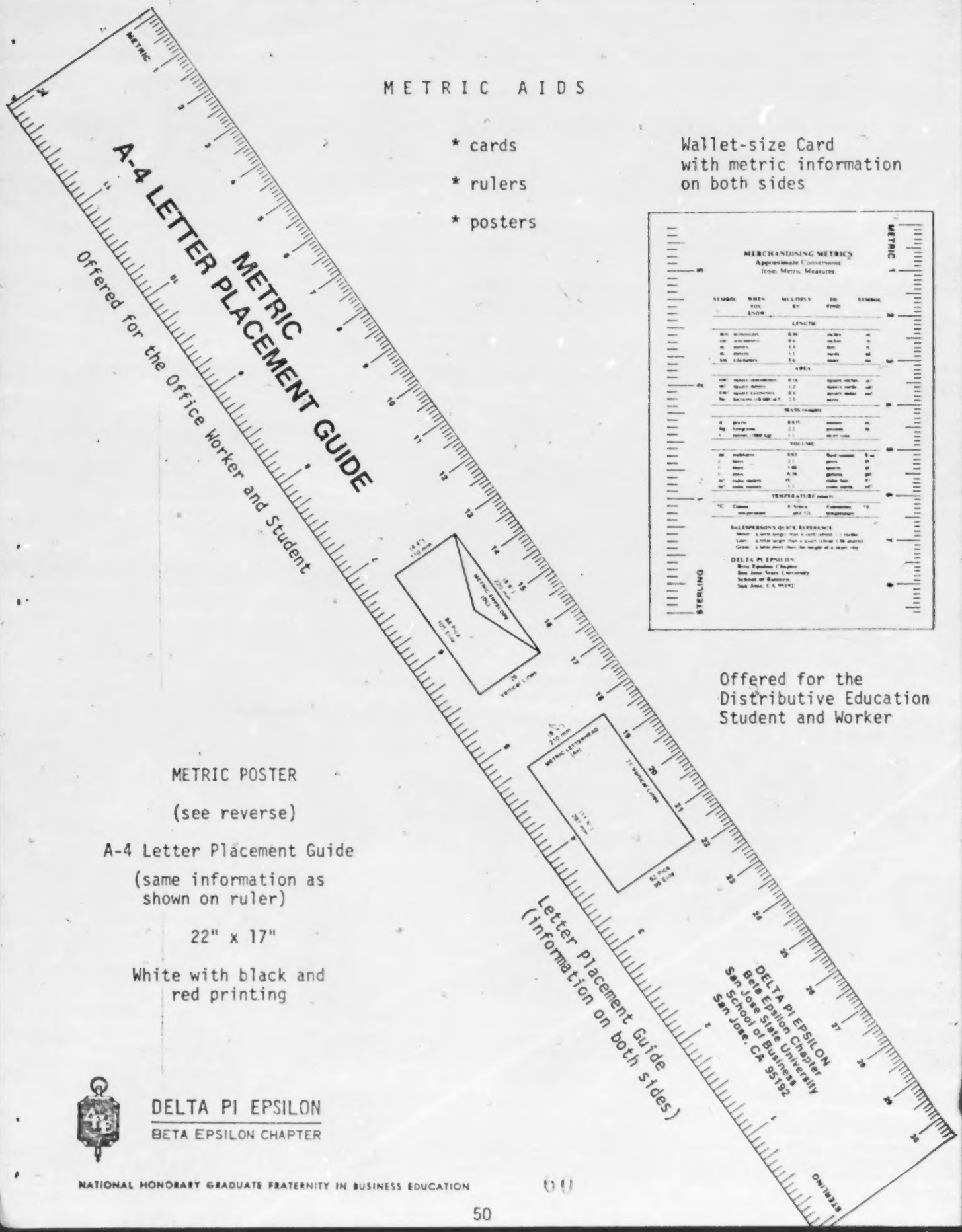
Distributive Education
Student and Worker



METRIC POSTER

(see reverse)

A-4 Letter Placement Guide

(same information as
shown on ruler)

22" x 17"

White with black and
red printing

DELTA PI EPSILON
BETA EPSILON CHAPTER

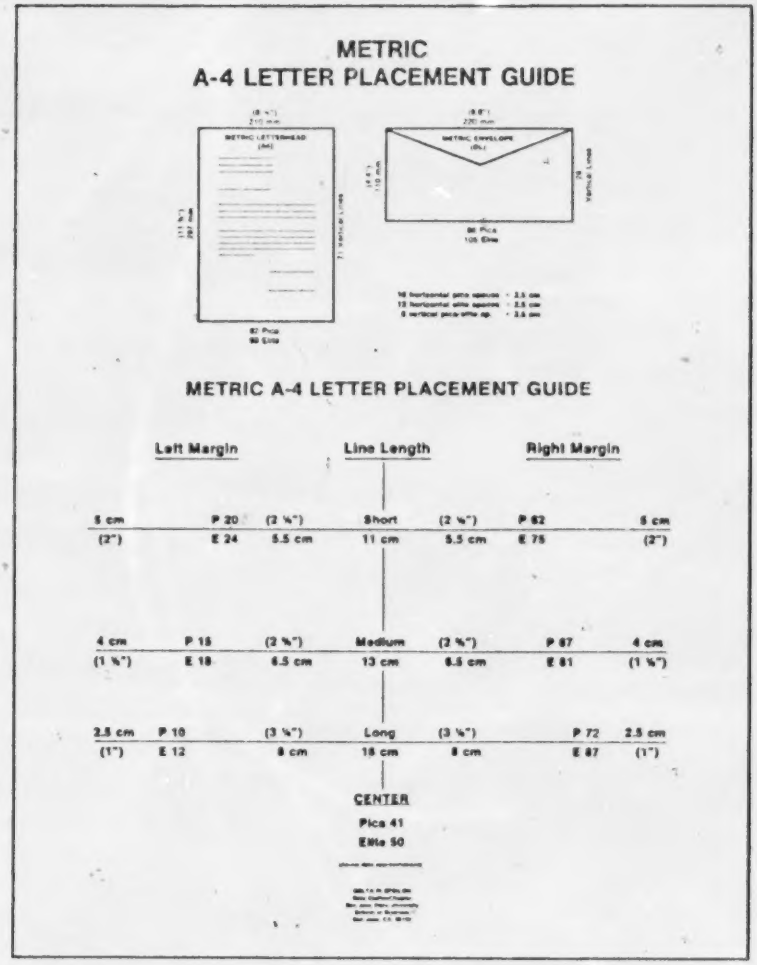
NATIONAL HONORARY GRADUATE FRATERNITY IN BUSINESS EDUCATION

METRIC POSTER

(shown 1/4 size)

Actual size
22" x 17"

White with black
and red printing



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DELTA PI EPSILON
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